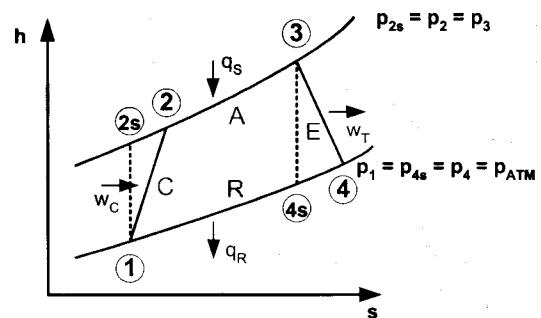
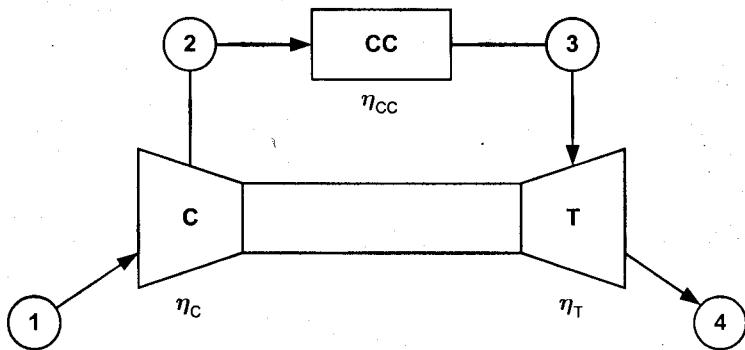


SINGLE SHAFT GT – ACTUAL
WITH COMPONENT EFFICIENCIES BUT NO PRESSURE DROPS



GIVEN → Atmospheric conditions: 14.7 psia, 70°F; Turbine inlet: 1800°F; Pressure ratio: 10
Component efficiencies: compressor 94%, combustion chamber 98%, and turbine 92%
Mass flow rate of air: 100 lb_m/min; Lower Heating Value of fuel: 18,300 Btu/lb_m

1. Draw actual GT cycle on h-s diagram above. Label state points.

* Note * State points 2s and 4s are the ideal (isentropic) state points. State points 2 and 4 are the actual state points used in all heat and work calculations. You must calculate state points 2s and 4s in order to obtain state points 2 and 4!

2. Complete the state point properties table using air tables (i.e. variable specific heat):

	1	2s	2	3	4s	4
p [psia]	14.7	147.0	147.0	147.0	14.7	14.7
T [°R]	530	1015	1025	2260	1258	1342
h [Btu/lb _m]	126.7	244.8	247.2	577.2	306.1	327.8
Pr	1.299	12.99	13.458	285.913	28.591	36.508

$$r_p = \frac{p_2}{p_1} = \frac{Pr_{2s}}{Pr_1}$$

$$\frac{p_3}{p_4} = \frac{Pr_3}{Pr_{4s}} = r_p$$

$$2_s \rightarrow 2 : \eta_C = \frac{h_{2s} - h_1}{h_2 - h_1}$$

$$4_s \rightarrow 4 : \eta_T = \frac{h_3 - h_4}{h_3 - h_{4s}}$$

Calculate work of the compressor, w_C [Btu/lb_m]

$$w_C = h_2 - h_1 = 247.2 - 126.7 = 120.5 \frac{\text{Btu}}{\text{lbm}}$$

Calculate work of the turbine, w_T [Btu/lb_m]

$$w_T = h_3 - h_4 = 577.2 - 327.8 = 249.4 \frac{\text{Btu}}{\text{lbm}}$$

Calculate heat supplied, q_S [Btu/lb_m]

$$q_S = h_3 - h_2 = 577.2 - 247.2 = 330.0 \frac{\text{Btu}}{\text{lbm}}$$

Calculate heat rejected, q_R [Btu/lb_m]

$$q_R = h_4 - h_1 = 327.8 - 126.7 = 201.1 \frac{\text{Btu}}{\text{lbm}}$$

Calculate cycle thermal efficiency, η_{TH} [%]

$$\eta_{TH} = \frac{W_{net}}{q_S} = \frac{W_T - W_C}{q_S} = \frac{q_{net}}{q_S} = \frac{q_S - q_R}{q_S} = \frac{249.4 - 120.5}{330.0} = \frac{128.9}{330.0} = 39.1\% = \frac{330 - 201.1}{330}$$

Calculate mass flow rate of the fuel, \dot{m}_{FUEL} [lb_m/min]

$$\eta_{CC} = \frac{\dot{m}_{AIR}(q_S)}{\dot{m}_{FUEL}(LHV)} = .98 = \frac{100(330)}{\dot{m}_F(18,300)} \quad \dot{m}_F = 1.84 \frac{\text{lbm}}{\text{min}}$$

$$\text{OTHER CALC'S: } \dot{W}_{NET} = \dot{m}_{AIR}(W_{NET}) = 100 \frac{\text{lbm}}{\text{min}} (128.9 \frac{\text{Btu}}{\text{lbm}}) \left(\frac{1 \text{ HP}}{42.42 \frac{\text{Btu}}{\text{min}}} \right) = 303.9 \text{ HP (ihp)}$$